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**APPLICATION
FOR
UNITED STATES PATENT**

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Title: ORVR COMPATIBLE VACUUM ASSIST FUEL
DISPENSERS

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SPECIFICATION

ORVR COMPATIBLE VACUUM ASSIST FUEL DISPENSERS

This claims the benefit of U.S. Provisional Patent Application Serial No. 60/461,097, filed April 8, 2003 and which is hereby incorporated by reference in its entirety.

Background of the Invention

This invention relates generally to refueling systems for vehicles and, more particularly, to assist-type vapor recovery systems for the refueling of vehicles.

5 In fuel dispensing systems, such as those used for
delivering gasoline to the fuel tank of a vehicle, environmental protection
laws require that vapors emitted from the tank during the fuel dispensing
process be recovered. Fuel is customarily delivered through a nozzle via
a fuel hose and vapors are recovered from the nozzle via a vapor hose
10 that conveys the vapor to the storage tank from whence the fuel came.

In what is referred to as a balanced system, the vapors are forced through the vapor hose by the positive pressure created in the vehicle tank as the fuel enters it. In other systems, referred to as assist-type systems, the vapor is pumped from the vehicle tank and forced into the storage tank by a vapor recovery system connected to the vapor hose. Currently, many fuel dispensing pumps at service stations are equipped with vacuum assisted vapor recovery systems that collect fuel vapor vented from the fuel tank filler pipe during the fueling operation and transfer the vapor to the fuel storage tank.

Recently, onboard, or vehicle carried, fuel vapor recovery and storage systems (commonly referred to as onboard recovery vapor recovery or ORVR) have been developed in which the head space in the vehicle fuel tank is vented through a charcoal-filled canister so that the vapor is absorbed by the charcoal. Subsequently, the fuel vapor is withdrawn from the canister into the engine intake manifold for mixture and combustion with the normal fuel and air mixture. The fuel tank head space must be vented to enable fuel to be withdrawn from the tank during vehicle operation. In typical ORVR systems, a canister outlet is connected to the intake manifold of the vehicle engine through a normally closed purge valve. The canister is intermittently subjected to the intake manifold vacuum with the opening and closing of the purge valve between the canister and intake manifold. A computer which monitors various vehicle operating conditions controls the opening and closing of the purge valve to assure that the fuel mixture established by

the fuel injection system is not overly enriched by the addition of fuel vapor from the canister to the mixture.

Fuel dispensing systems at service stations having vacuum assisted vapor recovery capability which are unable to detect ORVR systems waste energy, increase wear and tear, ingest excessive air into the underground storage tank and cause excessive pressure buildup in the piping and underground storage tank due to the expanded volume of hydrocarbon saturated air.

Refueling of vehicles equipped with ORVR can be deleterious for both the vapor recovery efficiency of a vapor recovery system and the durability of some system components. The refueling of an ORVR equipped vehicle deprives the vapor recovery system of any gasoline vapors intended to be returned to the storage tank, typically located underground. In lieu of having gasoline vapor available, the vapor pump of an assist-type system will pump air back into the storage tank. The air pumped back into the storage tank vaporizes liquid fuel that is in the storage tank, pressurize the ullage space of the storage tank and is then vented to the atmosphere as polluting emissions.

One known type of assist vapor recovery system attempts to avoid the storage tank pressurization problem by sensing the presence of an ORVR equipped vehicle during refueling and uses this information to turn off the vapor pump during the refueling of an ORVR vehicle. As systems ability to recognize an ORVR system and adjust the fuel dispenser's vapor recovery system accordingly eliminates the

redundancy associated with operating two vapor recovery systems for one fueling operation. One example of this type of system is described in U.S. Patent No. 5,782,275 issued to Gilbarco and hereby incorporated by reference. The reduction in vapor or air flow rate during an ORVR refueling will be 100% when the vapor pump is turned off; however, some initial run time is required for the pressure sensor to activate and turn the pump off.

Another example of an assist vapor recovery system is described in U.S. Patent No. 6,095,204 issued to Healy and hereby incorporated by reference. The system of the '204 patent uses a pressure sensor in place of the hydrocarbon sensor to determine if an ORVR refueling event is taking place and subsequently turn the vapor pump on/off. Therefore, an overall reduction of only about 75% is typical for such a system.

Another type of known assist system utilizes a vapor flow restrictor built into the nozzle to decrease the vapor flow back to the storage tank during an ORVR refueling event. The nozzle for such a system utilizes a flexible boot to engage the filler neck of a vehicle, but an air-tight seal is prevented. In such systems, if an air-tight seal were present when a vapor pump is being used in conjunction with an ORVR vehicle, relatively high vacuum levels develop within the vapor space of the nozzle. These abnormally high vacuum levels cause abnormal operation of the automatic shut-off mechanism in the nozzle. The nozzle for such a system utilizes either a check valve or holes in the boot itself

to limit the amount of vacuum to which the nozzle is exposed. Such vacuum relief measures allow the vacuum level to increase to a detectable level within the nozzle and the elevated vacuum level is used to operate a flow restrictor in the vapor flow path. The exact reduction in vapor (air) flow rate during an ORVR refueling with such a system is from 25% to 78% depending on the exact configuration and fueling flow rate.

Automobiles equipped with onboard vapor recovery systems (ORVR) prevent the vapors in the gasoline tank of the automobile from being transferred to the underground storage tank (UST) using the vapor recovery equipment on the gasoline dispenser (nozzle, hose, vapor pump, etc.). With no gasoline vapors to transfer from the vehicle to the UST, the vapor recovery equipment will intake, and transfer to the UST, only air, which will cause the pressure in the UST to increase because the ingested air will vaporize liquid fuel that is in the UST. As the pressure in the UST increases, the emissions from the vapor recovery system increase from leaks in the system (fugitive emissions). In order to make the assist-type gasoline dispenser compatible with ORVR equipped vehicles, the amount of air transferred to the UST when fueling an ORVR equipped vehicle must be reduced. Therefore, there will necessarily be some sort of "seal" between the nozzle and the filler neck to prevent the ingestion of air into the vapor recovery system and into the UST. Any pressure or vacuum in the filler neck (relative to atmospheric pressure) could adversely affect the

operation of the shut-off, causing either premature shut-off with a vacuum present, or no shut-off with pressure present.

5 However, these and other known systems do not provide for assist-type vapor recovery systems that are compatible with ORVR systems while still maintaining the accurate and reliable operation of the automatic shut-off mechanism in the nozzle.

Summary of the Invention

10 These and other problems with known fuel dispensing and associated vapor recovery systems have been overcome with this invention.

15 According to one embodiment of this invention, an improved nozzle and vapor recovery system configuration makes an assist-type gasoline dispenser compatible with ORVR equipped vehicles. Specifically, the spout shut-off mechanism of a nozzle functions without regard to variations in the level of vacuum in the filler neck, such as may occur with on board vapor recovery systems on autos.

20 This invention utilizes an assist-type of nozzle and a flexible boot to seal against the filler neck of the vehicle being refueled. This arrangement results in relatively high vacuum levels in the nozzle vapor space. To account for those vacuum levels, the shut-off mechanism is modified. Since the nozzle boot is sealed against the

vehicle's filler neck, the vapor recovery system will not ingest any air into the storage tank.

Current mechanical shut-off mechanisms for nozzles consist of a diaphragm operated shut-off mechanism, one side of which vents to atmospheric pressure at the nozzle, the other vented to a vacuum producing poppet valve, which in turn vents to the atmosphere at the end of the nozzle spout. This invention vents both sides of the diaphragm at the end of the spout. Two separate passageways lead from the nozzle spout, one leading to the vacuum producing device, then to one side of the diaphragm, the other passageway leading to the opposite side of the diaphragm.

By venting both sides of the shut-off diaphragm in the same area in the filler neck, the shut-off diaphragm will not sense that there is any pressure or vacuum present on the filler neck (relative to atmospheric pressure) and the shut-off mechanism will operate in a normal manner. This invention allows the mechanical shut-off mechanism of the nozzle to be retained without modification and does not require, for example, conversion to an electronic shut-off. The respective spout vents may be positioned in several ways and only need to be in the same area of the filler pipe relative to any pressure variations that are present. In an alternative embodiment of the nozzle according to this invention, the back side of the diaphragm is vented into the vapor path of the nozzle instead of a separate tube into the spout.

As a further alternative, a vacuum assist vapor recovery dispenser is modified to render it ORVR compatible. Specifically, a bypass valve coupled to the vapor return line reduces the quantity of air ingested during refueling and minimizes the amount of air returned to the underground storage tanks (UST).

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A bypass valve is connected across the inlet and outlet of the vapor pump in the gasoline dispenser. The valve, which is normally closed, is operated by a diaphragm, or other suitable means, connected to the inlet side of the vapor pump. Normally, the level of vacuum of the inlet to the pump is very low, i.e., the level merely corresponds to the pressure drop in the nozzle/hose/plumbing on the inlet side. With an ORVR vehicle, the vacuum level increases substantially due to the lack of vapor flow. This increased vacuum causes the bypass valve to open, simply allowing flow to recirculate at the vapor pump. This reduces the vapor/air flow back into the UST with an ORVR vehicle, reducing the pressurization of the UST.

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As a further alternative, a valve is placed on the inlet side of the vapor pump only. This valve is normally open. With an ORVR vehicle, the vacuum level increases substantially due to the lack of vapor flow. This increased vacuum causes the valve to close the inlet to the vapor pump. This reduces the vapor/air flow back to the UST with an ORVR vehicle, reducing the pressurization of the UST.

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Additionally, a secondary feature can be added to either valve configuration so that the vacuum level at the nozzle and filler neck

can be regulated. A secondary valve is operated by the primary valve so that once the primary valve has substantially closed the inlet side of the pump, the secondary valve is opened to regulate the vacuum level created by the ORVR system onboard the vehicle. With the

5 modifications made to the nozzle as described herein, the nozzle's shut-off characteristics are unaffected by the vacuum level in the filler neck, but the substantially elevated vacuum levels can cause the liquid in the filler neck to become elevated within the filler neck, and if the liquid reaches the tip of the nozzle, the nozzle's shut-off mechanism will

10 function as it is intended to do.

During the refueling of an ORVR equipped vehicle, the vacuum levels will rise quickly to about 7 inches H₂O vacuum at which point the valve will be set to actuate. With the valve actuated, the vacuum levels on the pump side will increase substantially to the limits of

15 the pump design. The vacuum levels on the nozzle side of the valve would similarly increase due to the action of the ORVR mechanism in the vehicle, but the secondary valve opens to reduce the vacuum level to prevent the liquid from shutting the nozzle off. It has been determined that a vacuum level in the filler neck of 3.0 - 5.0 inches H₂O can be

20 tolerated during refueling.

The above-described approaches provide advantages in reduced cost and simple installation. Specifically, a reconfiguration of existing dispenser plumbing and the modification to the nozzle is all that is required. The nozzle still has to stay "on" long enough to operate the

valve, and there is still a substantial amount of vacuum in the filler neck from the ORVR action of the vehicle. The valve is a necessary part primarily because of the liquid in the filler neck as described above. The valve itself could be placed in the hose or in the dispenser. Further, a
5 bypass valve is a much cheaper piece of hardware than, for example a hydrocarbon sensor, is often faster to respond, and does not require any electrical connections or electrical control means. Finally, the bypass valve configuration can be retrofitted into existing dispenser vapor plumbing.

10 **Brief Description of the Drawings**

The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention itself will be better understood by reference to the following description of embodiments of the invention taken in
15 conjunction with the accompanying drawings, wherein:

Fig. 1 is a fueling system for a vehicle according to one embodiment of this invention;

Fig. 2 is a cross-sectional view of an ORVR compatible dispenser nozzle according to one embodiment of this invention;

20 Figs. 2A and 2B are enlarged views of the area 2A in Fig. 2 showing an inlet of the vent tube in two configurations;

Figs. 3-5 are cross-sectional views of embodiments of an assembly which may be used in a vapor recovery system of the fueling system of Fig. 1;

5 Fig. 6 is a schematic illustration of an ORVR compatible dispenser nozzle configuration according to one embodiment of this invention;

Fig. 7 is a schematic illustration of an ORVR compatible dispenser nozzle configuration according to another embodiment of this invention; and

10 Fig. 8 is a schematic illustration of a vapor return bypass configuration for an ORVR compatible dispenser according to one embodiment of this invention.

Detailed Description of the Invention

Referring to Fig. 1, a vehicle 10 is shown being fueled with a fueling system 12. A nozzle 14 is shown inserted into a filler pipe 16 of a fuel tank 18 of the vehicle 10 during the fueling operation.

15 A fuel delivery hose 20 is connected to the nozzle 14 on one end and to a fuel dispensing system 22 on the opposite end. The fueling system 12 includes a vapor recovery system 24. As shown by
20 the cut-away view of the interior of the fuel delivery hose 20, an annular fuel delivery passageway 26 is formed within the fuel delivery hose 20 for delivering fuel by a pump 28 from an underground storage tank 30 to the nozzle 14. A central, tubular vapor passage 32 as part of the vapor

recovery system 24 is also within the fuel delivery hose 20 for transferring fuel vapors expelled from the vehicle's fuel tank 18 to the underground storage tank 30 during the fueling of the vehicle 10. The fuel delivery hose 20 is depicted as having the internal vapor passage 32 with the fuel delivery passage 26 concentrically surrounding it.

As shown in Fig. 1, the underground storage tank 30 includes a vent pipe 34 and a pressure vent valve 36 for venting the underground tank 30 to the atmosphere. The valve 36 vents the tank 30 to air at about 3.0 inches H₂O or -8.0 H₂O.

A vapor recovery pump 38 provides a vacuum in the vapor passage 32 for removing fuel vapor during a refueling operation. The vapor recovery pump 38 may be placed anywhere along the vapor recovery system 24 between the nozzle 14 and the underground fuel storage tank 30. Vapor recovery systems 24 utilizing a vapor recovery pump 38 of the type shown and described herein are well known in the industry and are commonly utilized for recovering vapor during refueling of conventional vehicles which are not equipped with on-board vapor recovery systems (ORVR). The vehicle 10 as shown in Fig. 1 being fueled includes an ORVR system 40.

The vehicle fuel tank 18 of an ORVR vehicle 10 has an associated on-board vapor recovery system 40. These ORVR systems 40 typically have a vapor recovery inlet 42 extending into the fuel tank 18. As the fuel tank 18 fills, pressure within the tank 18 increases and forces vapors into the ORVR system 40 through the vapor recovery inlet

42. Alternatively, the ORVR system 40 may use a check valve (not shown) along the filler pipe 16 to prevent further loss of vapors.

5 As liquid fuel rushes into the fuel tank 18 during the fueling operation, fuel vapors are forced out of the fuel tank 18 through a spout 44 of the nozzle 14. The vapor recovery system 24 pulls the fuel vapors through the hose 20 along the vapor passage 32 and ultimately into the underground tank 30. This is the standard operation when fueling vehicles not equipped with ORVR systems.

10 According to this invention as shown in Figs. 2, 2A, 2B and 6-8, the illustrated nozzle 14 configurations may be utilized to make an assist-type vapor recovery system 24 of the gasoline dispenser 22 compatible with ORVR 40 equipped vehicles 10. Specifically, a fuel shut-off mechanism 100 of the nozzle 14 functions without regard to variations in the level of vacuum in the filler neck 16, such as may occur
15 with ORVR systems 40.

Current mechanical shut-off mechanisms 100 for nozzles 14 include of a diaphragm 102, one side 104 of which vents to atmospheric pressure at the nozzle 14, the other side 106 of which is vented to a vacuum producing poppet valve 108, which in turn vents to
20 the atmosphere at the end of the nozzle spout 44. This invention vents both sides of the diaphragm 102 (Figs. 6-7) at the end of the spout 44. Two separate passageways 110, 112 lead from the end of the spout 44, one passageway 110 leading to the vacuum producing device 108, then

to one side 104 of the diaphragm 102, the other passageway 112 leading to the opposite side 106 of the diaphragm 102 (see Fig. 6).

To make the assist-type vapor recovery system 24 compatible with ORVR 40 equipped vehicles 10, the amount of air transferred to the UST 30 when fueling an ORVR equipped vehicle 10 must be reduced. By venting both sides 104, 106 of the shut-off diaphragm 102 in the same area in the filler neck 16, the shut-off diaphragm 102 will not sense that there is any pressure or vacuum present on the filler neck 16 (relative to atmospheric pressure) and the shut-off mechanism 100 will operate in a normal manner. The illustrated configuration allows the mechanical shut-off mechanism 100 of the nozzle 14 to be retained without modification and does not require, for example, conversion to an electronic shut-off. The respective vents or passages 110, 112 may be positioned in several ways and only need to be in communication with the same area of the filler pipe 16 relative to any pressure variations that are present.

Referring to Fig. 2, a cross-sectional view of one embodiment of a nozzle 14 according to this invention is shown. The nozzle 14 includes the spout 44 projecting forwardly from a nozzle body assembly 114. On the nozzle body assembly 114 opposite from the spout 44, the hose 20 is connected to the nozzle 14 as is shown in Fig. 1. The nozzle 14 includes a collection sleeve or boot 116 mounted to the forward end of the nozzle body 114 and surrounding the spout 44. The collection sleeve 116 includes a molded face seal 118 flared outwardly

at a terminal end of the collection sleeve 116. The collection sleeve 116 has a series of corrugations 120 which provide flexibility to the collection sleeve 116 so that when the nozzle 14 and spout 44 are inserted into the filler pipe 16 of the vehicle 10 as shown in Fig. 1, the molded face seal 118 mates with the filler pipe 16 and surrounding portion thereof on the vehicle 10 to provide an air-tight seal substantially preventing the escape of air or vapor into or from the filler pipe 16 and collection sleeve 116 area.

The nozzle 14 also includes the shut-off mechanism 100 having a portion thereof seated at an upper end of the spout 44 at the juncture with the nozzle body 114. The mechanism 100 includes a venturi bushing body 122 and a venturi poppet member 124 having a head 126 and a stem 128 projecting from the head 126. The stem 128 is seated within the bushing body 122 and a spring 130 is seated within the head 126 and concentrically around the stem 128 to bias the poppet member 124 outwardly from the body 122. The shut-off mechanism 100 is standard in many nozzle designs known in the industry and advantageously requires no modification according to this invention for proper operation.

The nozzle body 114 includes a standard trigger lever 132 which is pivotally coupled by a pin 134 to the lower end of a shut-off actuator stem assembly 136. The lever 132 includes a grip 138 for actuation by a user to dispense fuel through the nozzle 14 and into the vehicle 10. The nozzle body 114 includes a lever guard 140 surrounding

the lever 132 as is customary in many nozzle configurations. A lock 142 is provided to releasably retain the lever 132 in an "on" position as in well known.

5 The head 126 of the poppet member 124 is seated in an inlet 144 of a chamber 146 in the nozzle body 114. The chamber 146 is in communication with the upper first side 104 of the diaphragm 102 (see Figs. 6 and 7). The shut-off actuator stem assembly 136 is in communication with the opposite or lower side 106 of the diaphragm 102 of the shut-off mechanism 100. As fuel fills the tank 18 and the tank 18 becomes full, the fuel backs up into the spout 44 and actuates the poppet member 124 to project from the inlet 144 into the chamber 146 thereby increasing the pressure on the first side 104 of the diaphragm 102 and triggering the shut-off stem assembly 136 to turn off the flow of fuel through the nozzle 14. The stem 148 extends
10 downwardly thereby releasing the lever 132 coupled thereto by the pin 134. This operation of the components of the shut-off mechanism 100 in the nozzle 14 is according to well known designs.

According to the nozzle 14 configuration of this embodiment of the invention, two vapor passageways 110, 112 are
20 provided. Each of which is in communication with one side 104, 106, respectively, of the diaphragm 102. The first passage 110 is indicated by arrows A in Fig. 2. The first passage 110 provides a vacuum path from the ORVR system 40 of the vehicle 10 through the filler pipe 16 of the vehicle 10. Since the molded face seal 118 provides a substantially

air-tight seal with the filler neck 16, the first passage 110 is from the filler pipe 16 through the collection sleeve 116 exterior to the spout 44. The space contained within the collection sleeve 116 exterior to the spout 44 is in communication with a port 150 in the nozzle body 114. The port 150 is in communication with an upper channel 152 through the nozzle body 114 which, as shown by arrows A in Fig. 2, traverses through the nozzle body 114 into communication with the side 106 of the diaphragm 102 of the shut-off mechanism 100 (see Figs. 6-7).

The second vacuum passage 112 is also provided through the nozzle 14. In one embodiment, the passage 112, as identified by arrows B in Fig. 2, is provided through a side vent 154 in the spout 44. The side vent 154 includes a vacuum sensing screw 156 having a central aperture 158 there through and seated within a check valve body 160 mounted on the interior of the spout 44. The check valve body 160 includes an internal annular channel 162 in which a check valve ball 164 is contained. The check valve ball 164 is sized and configured for sealing engagement with a tapered neck portion 166 of the annular channel 162 as shown in Fig. 2A. The check valve ball 164 provides a seal or closes the passage 112 in the configuration of Fig. 2A. When the pressure in the passage 112 changes, the check valve ball 164 translates into engagement with the end of a vent tube 168 coupled to the check valve body 160. When the ball 164 is in the configuration of Fig. 2B, the vapor passage 112 is opened through ducts 170 in the valve body 160 bypassing the valve ball 164. The vent tube 168 has a central

opening 172 there through for communication with the opposite side 104 of the diaphragm 102 as shown in Figs. 6 and 7.

Therefore, as a result of the nozzle configuration shown in Figs. 2, 2A, 2B, 6 and 7, by venting both sides 104, 106 of the shut-off diaphragm 102, the shut-off diaphragm 102 will not sense that there is any pressure or vacuum differential present on the filler neck 16 and the shut-off mechanism 100 will operate as designed. Therefore, the vacuum generated by the ORVR system 40 on the vehicle 10 and the vacuum generated by the vapor pump 38 of the vapor recovery system 24 of the fueling system 12 do not increase the vacuum level and draw fuel into the spout 44 of the nozzle 14 thereby prematurely actuating the shut-off mechanism 100.

Referring now to Fig. 7, the illustrated nozzle configuration is similar to that illustrated in Fig. 6, with the exception that the side 104 of the diaphragm 102 is vented into the vapor path of the nozzle 14 instead of the separate vent tube 168 into the spout 44.

As one alternative, a vacuum assist vapor recovery dispenser 22 may be modified in the manner illustrated in Fig. 8 to render it ORVR compatible. Specifically, a bypass valve 174 coupled to the vapor return line 32 is employed to reduce the quantity of air ingested during refueling and minimize the amount of air returned to the underground storage tanks 30.

Referring to Fig. 8, the bypass valve 174 is connected across the inlet and outlet of the vapor pump 38 in the gasoline

dispenser 22. The valve 174, which is normally closed, is operated by a diaphragm, or other suitable means, connected to the inlet side of the vapor pump 38. Normally, the level of vacuum of the inlet to the pump 38 is very low, i.e., the level merely corresponds to the pressure drop in the nozzle/hose/plumbing on the inlet side. With an ORVR vehicle 10, the vacuum level increases substantially due to the lack of vapor flow. This increased vacuum causes the bypass valve 174 to open, simply allowing flow to recirculate at the vapor pump 38. This reduces the vapor/air flow back into the UST 30 with an ORVR vehicle 10, reducing the pressurization of the UST 30.

As a further alternative, a valve (not shown) is placed on the inlet side of the vapor pump 38 only. This valve is normally open. With an ORVR 40 vehicle 10, the vacuum level increases substantially due to the lack of vapor flow. This increased vacuum causes the valve to close the inlet to the vapor pump 38. This reduces the vapor/air flow back to the UST 30 with an ORVR vehicle 10, reducing the pressurization of the UST 30.

Additionally, a secondary feature can be added to either valve configuration so that the vacuum level at the nozzle 14 and filler neck 16 can be regulated. A secondary valve (not shown) is operated by the primary valve so that once the primary valve has substantially closed the inlet side of the pump 38, the secondary valve is opened to regulate the vacuum level created by the ORVR system 40 onboard the vehicle 10. With the modifications made to the nozzle 14 as described

herein, the nozzle's shut-off characteristics are unaffected by the vacuum level in the filler neck 16, but the substantially elevated vacuum levels can cause the liquid in the filler neck 16 to become elevated within the filler neck 16, and if the liquid reaches the tip of the spout 44, the nozzle's shut-off mechanism 146 will function as it is intended to do.

During the refueling of an ORVR 40 equipped vehicle 10, the vacuum levels will rise quickly to about 7 inches H₂O vacuum at which point the valve will be set to actuate. With the valve actuated, the vacuum levels on the pump 38 side will increase substantially to the limits of the pump 38 design. The vacuum levels on the nozzle 14 side of the valve would similarly increase due to the action of the ORVR mechanism 40 in the vehicle 10, but the secondary valve opens to reduce the vacuum level to prevent the liquid from activating the shut-off mechanism 146. With such an arrangement, a vacuum level in the filler neck 16 of 3.0 - 5.0 inches H₂O can be tolerated during refueling.

The advantages of this invention relate to reduced cost and simple installation. Specifically, reconfiguration of existing dispenser plumbing and the modification to the nozzle are required. The nozzle 14 still has to stay "on" long enough to operate the valve, and there is still a substantial amount of vacuum in the filler neck 16 from the ORVR 40 operation. The valve could be placed in the hose 20 or in the dispenser 22. Further, a bypass valve is a much cheaper piece of hardware than, for example a hydrocarbon sensor, is often faster to respond, and does not require any electrical connections or electrical control means.

Finally, the bypass valve configuration can be retrofitted into existing dispenser vapor plumbing.

This invention may include an ORVR compatibility mechanism 46 as part of the dispenser system 12 as disclosed in U.S. Patent Application Serial No. 10/684,051, filed October 10, 2003 and hereby incorporated by reference. Various embodiments/configurations of the compatibility mechanism 46 are shown in Figs. 3-5. The ORVR compatibility assembly 46 is included in the fuel system 12 so that the vapor recovery system 24 of the fueling system 12 is compatible with the ORVR system 40 of the vehicle 10 during such a fueling operation. As shown in Fig. 1, the ORVR compatibility assembly 46 is located on the hose 20 at the opposite end from the nozzle 14; however, the compatibility assembly 46 can alternately be placed between the hose 20 and the nozzle 14, incorporated directly into the nozzle 14, or anywhere in the fueling system 12 in fluid communication with the vapor recovery system 24.

Referring to Figs. 3 and 4, the compatibility assembly 46 according to one embodiment of this invention includes a housing 48 with a primary vapor passage 50 there through and in communication with the vapor passage 32 in the hose 20. An upstream end 52 of the primary vapor passage 50 in the assembly 46 is connected through the hose 20 to the fuel nozzle 14 and, likewise, a downstream end 54 of the primary vapor passage 50 is in communication with the storage tank 30. For consistency herein, the end of the assembly 46 in communication

with the fuel tank 18 and nozzle 14 is referred to as the upstream end 52 and the end of the assembly 46 in communication with the underground storage tank 30 is the downstream end 54.

5 A valve assembly 56 is mounted for reciprocal movement in the housing 48 and intersects the primary vapor passage 50 in the assembly 46. The valve assembly 56 includes a sliding valve member 58 having a generally cylindrical portion 60 and a valve passage 62 which allows for vapor flow through the primary vapor passage 50 when the valve assembly 56 is in a first position as shown in Fig. 3. The
10 sliding valve member 58 reciprocates within a bore 64 in the housing 48 to a second position as shown in Fig. 4 in which the cylindrical portion 60 of the valve member 58 blocks or inhibits the vapor flow through the primary vapor passage 50.

An upper, proximal end 66 of the valve member 58 is
15 connected to a diaphragm, bellows or other expansible member 68 which is captured within a chamber 70 in the housing 48. A plate 72 is mounted between the upper end 66 of the valve member 58 and the diaphragm 68. A conical spring 74 is mounted between the plate 72 on the valve member 58 and an annular groove 76 in the housing 48. The
20 spring 74 urges or biases the valve member 58 upwardly so that the valve assembly 56 is urged toward the first position as shown in Fig. 3. A secondary vapor passage 78 connects the chamber 70 to the primary vapor passage 50 upstream from the valve assembly 56 as shown in Fig. 4. In an alternate embodiment, the secondary vapor passage 78 is

connected to the chamber 70 and the primary vapor passage 50 downstream from the valve assembly 56 as shown in Fig. 5.

5 A terminal end 80 of the valve member 58 includes a stop 82 juxtaposed to the housing 48. An O-ring 84 is seated on a beveled surface 86 of the stop 82 for sealing an annular pocket 88 in the housing 48. A stem 90 projects from the valve member 58 through the pocket 88 and is connected to the stop 82. In the first position of the valve assembly 56 as shown in Fig. 3, the O-ring 84 and stop 82 are seated against the housing 48 to seal off an air bleed port 92 connected to an
10 air bleed passage 94. The air bleed passage 94 is in communication with the primary vapor passage 50 upstream from the valve assembly 56. In the second position of the valve assembly 56 as shown in Fig. 4, the valve member 58 translates to extend the stop 82 from the sealing configuration with the housing 48 thereby opening the air bleed passage 94 for communication between the ambient atmosphere and the primary
15 vapor passage 50.

In operation, the force of the spring 74 on the plate 72 and diaphragm 68 keeps the valve member 58 in the first position as shown in Fig. 3 when refueling non-ORVR vehicles so that the primary passage 50 in the assembly 46 is unobstructed and the air bleed port 92 is
20 closed. When refueling non-ORVR vehicles, the vapor recovery system 24 in the fueling system 12 retrieves fuel vapors from the vehicle fuel tank 18 and pumps them to the ullage in the underground storage tank 30. When refueling an ORVR 40 equipped vehicle 10, elevated vacuum

levels in the vapor passage 32 of the hose 20 result from the vacuum pump 38 in the vapor recovery system 24 in combination with the ORVR system 40. The elevated vacuum levels are communicated through the primary and secondary vapor passages 50, 78 to the chamber 70. As a result of the elevated vacuum levels (or reduced pressure) in the chamber 70, the diaphragm 68 expands or moves within the chamber 70 as shown in Fig. 4. The movement of the diaphragm 68 likewise moves the valve member 58 toward the second position and overcomes the bias of the spring 74 while the reduced pressure or elevated vacuum condition exists in the chamber 70.

As a result of the movement of the diaphragm 68 and plate 72, compression of the spring 74 and translation of the valve member 58, the primary vapor passage 50 is blocked off because the valve passage 62 no longer provides for the flow of vapor in the primary vapor passage 50 through the assembly 46. Moreover, the vacuum of the vapor recovery system 24 is blocked from communicating with the ORVR system 40. The valve member 58 in the second position as shown in Fig. 4 blocks off the primary vapor passage 50 from the vacuum pump 38 of the vapor recovery system 24 and opens up the primary vapor passage 50 to the air bleed port 92. The size of the air bleed port 92 can be adjusted for compatibility with the containment pumping action of the ORVR filler neck to maintain the desired vacuum level in the passage 32 in vapor hose 20 to keep the valve member 58 in the second position.

As shown in Fig. 5, in an alternative embodiment the diaphragm chamber 70 is connected by the secondary vapor passage 78 downstream from the valve assembly 56. As such, when the elevated vacuum level or decreased pressure in the chamber 70 causes the valve member 58 to move to the second position, the vacuum level on the downstream end 54 or pump side of the valve member 58 will increase substantially and hold the valve member 58 in the second position until the pump 38 is stopped. In the embodiment of Fig. 5, the air bleed port 92 into the primary vapor passage 50 could be made as large as desired and even to the point of reducing the vacuum in the passage 32 of the vapor hose 20 below the valve assembly 56, including the nozzle vapor space to nearly zero. Nevertheless, in either embodiment of this invention reduction of vapor flow in the vapor passage 32 to the storage tank 30 would be at or near 100%.

The retrofit of an existing fuel system 12 to accomplish such an improvement is a simple matter of hanging a new nozzle assemble in the fuel system. It should be appreciated by those of ordinary skill in the art that the retrofit of existing fuel systems is easily accomplished with the implementation and installation of an assembly as described herein. Additionally, the installation of new fuel systems preferably includes an assembly according to this invention.

From the above disclosure of the general principles of the present invention and the preceding detailed description of at least one preferred embodiment, those skilled in the art will readily comprehend

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the various modifications to which this invention is susceptible.

Therefore, I desire to be limited only by the scope of the following claims and equivalents thereof.

I claim: